PEST TECHNOLOGY
Pest Control and Pesticides

A RHODES PUBLICATION

Vol. I. No. 7. April, 1959

CONTENTS

★

Published by:
Rhodes Industrial Services Limited,
274-276, The Corn Exchange, Fennel Street,
Manchester, 4.
DEAnsgate 4607/8

WELCOME !

IT has often been argued that research workers tend to reveal little or nothing of their activities until the particular investigation in hand has been completed. Even then, it is said, not in all instances are finalised reports issued as promptly as some would wish. Is there any need for this? We are prompted to ask this because of the enlightened approach of the Plant Industry Station, Beltsville, Maryland, which this year issued a progress report of work being done into an evaluation of several chemicals for their herbicidal properties.

The purpose of the report is to present the 1958 results of the primary field evaluation studies of the herbicide evaluation project conducted by personnel of the Weed Control in Crops Section, Crops Protection Research Branch of the Station. In all there are five objectives of the herbicide evaluation project: (1) to develop herbicide evaluation techniques; (2) to determine the response of crops and weeds to new chemicals applied as pre-emergence and post-emergence sprays; (3) to study the relationships between chemical structure and herbicidal activity; (4) to obtain preliminary information on the herbicidal properties of new chemicals and (5) to make this information available to Department of Agriculture personnel and co-operating state and chemical industry weed workers.

Twenty-six crop plants and seven weed species were seeded on the 21st May, 1958 and it is the evaluation of the work done to-date which has been published. As a progress report of co-operative investigation, the data contained may well be modified with additional experimentation. It is for this reason, therefore, that the Plant Industry Station requests that the results to-date be not published. This, of course is a wise precaution. Presumably by " published " is meant general distribution on a wide scale. Nevertheless the results to-date have been issued and the results are available to other research workers. It is this approach which makes the work so valuable, for there is no question of " keeping things to oneself." These preliminary field evaluation studies and analysed results, because of publication at this early stage, assume a value enhancing the project as a whole.

Research is international and co-operative interchange of knowledge in this way between interested workers can do nothing but good and help forward the finished work when finalised results will be available for distribution on a large scale.

We welcome this venture in co-operative research.

A SURVEY OF CERTAIN WEED CONTROL PROBLEMS IN AFRICA, SOUTH OF THE SAHARA

By E. R. HATTINGH

Introduction

SURVEYING tropical weed problems in Africa, Mr. E. R. Hattingh addressing the meeting at the Fourth British Weed Control Conference, said that it is recognised that especially in an undeveloped country, the natural vegetation or ecological types of a region give a guide to the important factors of climate and soils, which again govern the suitability or potential of the land for agriculture. Based on the work of Shantz and Marbut,[1] and Hall and Meredith[3] the region has been divided into eight distinct vegetation units or formations. The relative importance of these types is indicated in the following table:

VEGETATION TYPE	*Estimated Area in square miles*	%
Tropical Forest	1,191,800	13.8
Non-thorny woodland-tall grass	1,333,000	15.5
Non-thorny woodland-short grass	858,100	10.0
Thorny woodland-tall grass ..	1,950,800	22.7
Thorny woodland-short grass	1,514,432	17.6
Grassland	433,000	5.1
Macchia	278,300	3.2
Desert and Semi-desert ..	747,766	8.7
Others (Temperate forest, swamps)	304,108	3.4
	8,621,300	100.0

These regions have been indicated diagramatically, and it will be seen how the various formations are grouped in nearly concentric rings around the Tropical Rain Forest. The change from one type to another is gradual, except where distinct topographical changes occur, and is primarily a result of diminishing water supply, as can be seen from an inspection of the rainfall distribution over this area.

Tropical Rain Forest

The principal economic agricultural activities are growing of the oilpalm, cocoa, rubber, coffee, and to a lesser extent bananas and rice. Apart from weeds in these crops, the principal weed problem is the control of water hyacinth.

Non-thorny woodland with tall grass

Coffee, cotton, grain crops are the principal crops.

Non-thorny woodland—short grass

Cotton, grain sorghum, groundnuts and maize are grown. The maize producing area of the Rhodesias falls within this formation. Grazing is an important agricultural activity, and apart from weeds in the crops enumerated, the control of bush in pasture is important.

Thorny woodland—tall grass

Proceeding towards the drier areas the non-thorny woodland gives way to a type in which thorny species occur to a lesser or greater extent. The principal thorn species are *Acacias*, although other thorny species also occur. Crops of cotton and grain are produced in the better watered areas, but grazing is a principal activity. Control of bush and other unwanted plants such as jointed cactus and other sub-shrubs are examples of the weed problem.

Thorny woodland—short grass

In this drier type bunch grasses are common, and because of the paucity of grass, fires are of lesser importance than in the previous formation. According to Shantz[1] the border between successful and unsuccessful dryland production lies between these two types. Only drought enduring crops can be grown.

Semi-desert

The Karroo area of South Africa is included here—which incidentally provides excellent sheep pasturage. Chief weed problems are those associated with unbalance in the management systems.

Grasslands

This type develops under high altitude conditions—and in practice has often replaced a more montane type of vegetation. The Highveld of South Africa is characteristic. The region produces maize, root crops, sorghums, and is well suited to cattle grazing. The principal weed problems are those of the annual crops and in addition, invaders into the grassland, such as Stoebs, are of importance.

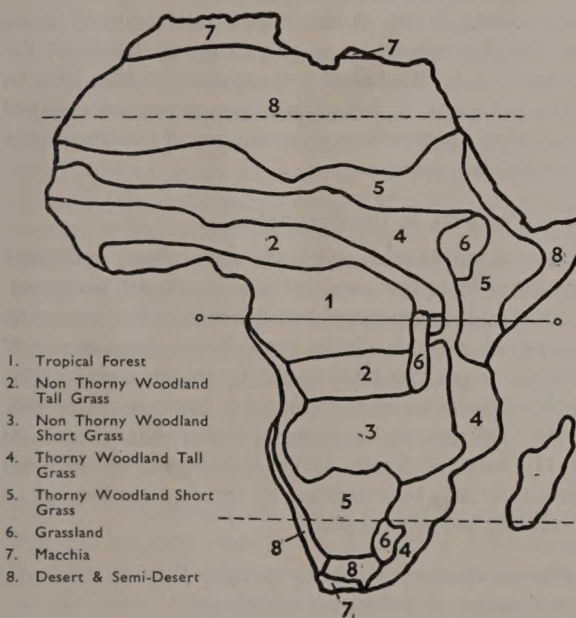
Human Aspects and General Weed Problems

The greatest problem to be overcome before general weed control can be carried out, is the poor education of the natives, who, in general, have no idea of scientific farming. There is obviously an abundance of cheap labour thus the use of herbicides is not very great. In fact there will be no reasonable demand for herbicides for use by the African himself on his own account for

15-50 years. However, large outlets for herbicides are likely to occur in the future from estates growing plantation crops, which have special weed problems and from authorities engaged in weed eradication on a National basis e.g. Tsetse fly control.

DIAGRAM OF VEGETATION

(AFTER GILLILAND, HALL & MEREDITH)



Specific Weed Control Problems

Certain major problems only, will be selected for review here viz.:

1. Control of bush and trees, and other weeds in natural grazing.
2. Control of weeds, principally grasses, in plantation crops.
3. Control of weeds in maize, chiefly by pre-emergence treatments.
4. Control of aquatic weeds.

(*a*) *Bush Control in natural grazing*

The control of undesirable weedy species is a problem which occurs in the vegetation types described here as non-thorny woodland with short grass; thorny woodland with tall grass and the shorter grass formation of the latter type. Due to encroachment of bush the carrying capacity of the veld is drastically reduced, trampling occurs in the open areas and soil erosion soon begins. Bush encroachment is one of Africa's most serious weed problems.

It is considered that the influence of Man through his grazing animals has been such that the delicate balance which existed between grass and bush has been upset, causing an acceleration of the succession towards thicket or forest types of vegetation.

Phillips[4,5,6] and West[7,8] find that absence of fire in conjunction with overgrazing leads to encroachment, and that the open woodland is really a pyreclimax. Fire may however, lead to coppicing of certain species,[9] and it is considered that the major effect of fire is to kill the seedlings and young trees, and not the more mature constituents of the vegetation, which under certain circumstances may thicken up as a result of firing.

The aspect of grass protection during the summer months in order to allow maximum competition between grass and bush has probably not been sufficiently stressed in the past. It has been found recently in the bush veld of South Africa;[10] that 3 seasons of summer resting alone (without fire) has brought about a complete kill of certain bush species such as *Acacia arabica; A.permixta* and *Dichrestachys glemarata.* Other species such as *A. hebeclada* are not affected in a similar manner, and even should this finding be confirmed in other regions, the problem of controlling certain bush species still remains.

(*b*) *Control of weedy growth in Tsetse control*

The selective control of woody species in order to open the community and admit more light is one of the means of controlling fly.

Burning has not always been successful and chemical control methods have been investigated as a possible means of liberating the vast areas under tsetse fly.

Use of Herbicides on Bush

Experiments conducted by the writer[13] on *Acacia detinens* and *A. heteracantha* in the South African Bushveld showed that diesel oil alone, applied to the crown of the tree, resulted in complete kill. Basal bark treatments were somewhat less effective, and the addition of a 4% w/v mixture of a 50:50 2,4-D/2,4,5-T low volatile ester mixture did not improve the results.

Cleghorn *et al*[12] also reports a 67% kill of *Acacia subalata* by applying illuminating paraffin to the crown of the tree. Similar results have been obtained in Natal,[14] and although erratic results have been obtained in practical use, this method of control is employed in certain areas of the Union.

In the Eastern Cape Province of South Africa, work has led to a recommendation of 0.75 lbs. 2,4,5-T ester in 10 gallons of diesoline as a basal spray for *Acacia* species,[15] but the results with this mixture in other regions have not always been satisfactory.

Trials reported from Southern Rhodesia[12] using 2,4,5-T and 2,4-D on a number of Acacia and non-thorny species, show a considerable variation in reaction according to species, type of herbicide applied, and method of application. In general, stem application has been more

successful than overall sprays, provided the herbicide is applied in a mineral oil carrier. Stump treatment, appears to be more reliable than bark treatment, but the most promising results on five Acacia species were obtained using 1.5% w/v butyl ester of 2,4,5-T in diesel oil applied to slashed stems. An average kill of 76% was obtained using 2,4,5-T; using diesel oil alone an average of 58% kill was obtained. A distinct species reaction was evident, diesel oil in the case of *A. karoo* and *A. subalata* giving 90% and 100% kill respectively, a better kill than where 2,4,5-T had been used as well, and in other cases the results were reversed. Why the addition of 2.4,5-T to the diesel oil produced a lower kill than oil alone is a question for further study, and is possibly due to some unmentioned factor.

Against non-thorny species in Rhodesia,[12] stump treatments appear to have given the most consistent results. There are indications that the low volatile esters of 2,4-D and 2,4,5-T are not as efficient as the butyl ester of 2,4,5-T on *Brachystegia spiciformis*, a 20% kill compared to a 75% kill respectively having been obtained. On *Papudoberlinia globiflora*, only a 15% kill using low volatile ester was obtained.

These results are in sharp contrast to these obtained by Ivens,[16] in East Africa where both of these last mentioned species have been very successfully controlled using a 1% solution of 2,4-D or 2,4,5-T in diesel oil. Furthermore good results have been achieved on a number of Acacia species e.g. *A. hebecaloides*, *A. drepanelobium;* and *A. tertilis* (heteracantha).

In East Africa, Ivens (*lec cit*) reports poor results on *Combretum*, *Euclia* and *Tarchomanthus*, species which tend to coppice if disturbed mechanically, and it appears that an important factor in determining whether a chemical treatment will be successful or not, may be the history of the tree itself, and its capability of producing coppice growth. This point is also made by Ivens (*lec. cit.*) and may account for the variation in results being obtained in different areas. The practice of shifting cultivators practiced by the Native Agriculturist has concerned many parts of these regions, and has probably resulted in the coppice type of growth widely encountered.

Results from overall spraying of 2,4,5-T on thorn scrub have no where been very successful. It is considered that this problem is of even greater importance than the need for a successful basal treatment, by virtue of the nature of the infestation in many areas.

It is considered that a field for fundamental investigation is the relationship between the effects of mineral oils and 2,4-D/2,4,5-T mixtures; effect of method of application and volume of application on final effect; influence of coppice growth; formulation of herbicides employed; influence of climate on species reaction, are certain of the problems needing evaluation before much progress can be made in this field. Spasmodic, unrelated experiments done at random are not likely to throw much light on this huge problem.

The question of the control of weedy growth is an interterritorial one, and of great importance in almost every country South of the Sahara, and a plea is made here for this subject to be placed in the hands of the Commission for Technical Co-operation in Africa South of the Sahara (C.C.T.A.),* who are at present engaged in handling another urgent weed control problem—that of *Eichhornia crassipes*.

Other Problems in Grazing Areas

Various sub-shrubs and herbaceous plants constitute a problem in certain areas of woodland and grassland. These plants are unwanted because they either reduce the amount of grass available, impede the movements of animals, or may be poisonous. In the grassland areas, *Stoebe vulgaris* is an example of a non-poisonous sub-shrub. This species has invaded over a million acres on the Highveld of South Africa, principally on reverted fallows. It may be controlled by means of herbicides or by burning in early summer.

Senecio species; *Pachystigma sp.; Geigeria africana*, are examples of poisonous sub-shrubs.

Jointed cactus, a low growing, vile weed over about 3 million acres in the Eastern Cape Province, is a gigantic problem and is being controlled by State subsidised 2,4,5-T butyl ester in illuminating paraffin. The upright prickly pear (*Opuntia sp.*) has been reduced in extent biologically, and mechanically except in the coastal regions. 2,4,5-T is effective against this species.

In the moister regions of Natal, encroachment by woody species such as American Bramble (*Bubus sp.*) in grassland and in wattle plantations, is typical of the problem.

Weed Control in Plantation Crops

It is intended to deal briefly with weed control in the more important plantation crops of coffee, tea, sisal and sugarcane. An important weed problem in plantation crops is the control of perennial grass species.

In the Belgian Congo, *Paspalum conjugation; P. virgatum* are troublesome.[17] Fleming[18] has recently reviewed this subject and detailed observations on the problem may be obtained from this source.

* *An international body consisting of Britain, France, Belgium, Portugal, Central African Federation and the Union of South Africa.*

It is clear that the control of perennial rhisomatis grasses such as couch, is a problem which cannot be satisfactorily concluded using mechanical methods, and although cheap labour is available at present, the trend is for labour to become more scarce, which increases the interest in chemical control measures.

When dealing with the control of perennial grasses, it must be remembered that the natural phenomena of plant succession is always at work, and that the removal of a sward of perennial grasses either mechanically or by a non-sterilising chemical, automatically opens the way for invasion by pioneers, usually broad leaved weeds and *Cyperus spp*. This phenomena is not always fully understood by planters and a treatment which may be successful in controlling the principal weed is very often condemned because of the subsequent weed invasion. It is desirable therefore, that in order to maintain a plantation free of weeds by chemical means, that the initial application be a chemical designed to deal with the perennial grass, and that subsequent treatments be applied before the perennial weeds fully re-establish themselves, but after the germination of the annuals, in order to prevent seeding. This may call for a combination of herbicides for the second follow-up treatment.

Coffee. Herbicides for use in coffee are restricted in that the slightest taint in the bean is a disadvantage. It is important therefore that apart from actual ill effects on the crop, that absorption must be reduced to a minimum. TCA was first tried as a herbicide against couch in this crop, but it was found that phytotoxic symptoms in the crop developed[19] and this herbicide was dropped in subsequent trials.

Dalapon at 10-20 lbs. per acre was found to give satisfactory results, and a considerable amount of work using this herbicide alone and in combination with amino triazole was undertaken at the Jacaranda Coffee Research Station, in Kenya, and by Ivens of the Colonial Pesticides Research Unit, Arusha, Tanganyika.[18] Ivens[19] has reported that Dalapon or amino triazole at 5-10 lbs. per acre has given a high degree of control for at least 12 weeks, but considers that more work is required on the most effective time for spraying. Two applications of Dalapon, either at 2½ or 5 lbs. per acre, has also given effective control of couch. Coffee can generally withstand dosages of up to 10 lbs. per acre, but it is considered that further work is also needed to clarify this point. It does appear that repeated low applications may be more effective and less injurious to the coffee than a single high application. The advantage of combining Dalapon with amino triazole does not appear to be clear, especially as final evaluation of results must be on a cost efficiency basis. However, should amino triazole be capable of controlling the invading broadleaved weeds, there may be a place for a mixture of Dalapon and amino triazole in a chemical weed control programme in coffee.

Tea. The main weed problem in tea occurs during the first few years of establishment as at this time the young plant is particularly susceptible to weed competition. Once the crop achieves a canopy the shade is sufficient to reduce weed competition to a minimum. However, during the pruning year when light is again allowed to enter, the problem may reoccur. The use of systemic grass herbicides appears to have possibilities in tea, but there is insufficient evidence regarding the tolerance of tea to applications of Dalapon or other herbicides.

Sugar Cane. Sugar cane is cultivated in Uganda, Tanganyika, Mozambique, Angola and the Union of South Africa. It is a high yielding crop and the economics are such that the use of herbicides is usually a practical undertaking. In Natal the sugar cane crop is the highest user of chemicals per unit area in agricultural practice at present. Except in certain restricted areas, as in Uganda for instance, the problem of perennial grasses is of secondary importance to the control of annual grasses and broadleaved weeds, and particularly *Cyperus spp*. For the control of annual weeds and *Cyperus spp*., pre-emergence applications of 2,4-D or

MCPA ranging between 2-4 lbs. acid equivalent per acre are normally employed, which provides weed control for 4-6 weeks. Should however, grasses and *Cyperus spp.* have germinated before it has been possible to apply pre-emergence spray, a combination of 4-5 gallons 5% Pentachlorophenol may be applied together with a growth regulator. In this manner the control of emergent grasses is achieved together with the residual action of the growth regulator. In certain cases this combination spray may be applied up to the spike or flag stages of the cane, when minimum scorch occurs.

Where *Cyperus spp*. are severe it is common in Natal to apply a subsequent application of pentachlorophenol. This, however, entails considerable scorching of the crop. The use of TCA at 15 lbs. per acre or Dalapon at 5-10 lbs. per acre, has been found to give satisfactory control of Cyperus with minimum damage to the cane.

The use of substituted ureas has not been found satisfactory on a cost/efficiency basis. Simazin has also been investigated, but as yet satisfactory results have not been obtained.

Sisal. Labour engaged in Sisal production in East Africa is demanding wage increases and this is causing increasing interest in chemical weed control. The use of herbicides in Sisal must be considered as largely experimental and their role in the future will probably be that of assisting rather than replacing hand and mechanical methods of weed control. In general the present low prices being obtained for Sisal rather limit the extensive use of herbicides.

Weed control is most important in the establishment period. It has been estimated that at present hand-weeding of nurseries may cost up to 250/-—300/- per acre.

WEED CONTROL IN FIELD CROPS

Introduction

The control of annual weeds in field crops such as maize, beans, groundnuts, sorghum and potatoes, presents problems wherever they are grown. For the purpose of this review weed control in the principal field crop—maize, will be reviewed. The fact that weeds are depressing to the yield of maize is well known. In South Africa the problem has received a little attention and work recently completed by Marais[22] at the Reitvlei Experimental Station, near Pretoria, clearly emphasises the need for efficient weed control. This worker has shown that the more favourable the conditions are for maize growth, the greater the reduction in the potential yield of the crop when in competition with weeds. This work shows that weed control operations should be aimed at securing a weed free crop from 30-50 days after planting. Because of the difficulty of eradicating weeds, particularly grass weeds, once they have become established, the only practical method of achieving this object is to begin weed control operations from the date of planting, and this is most feasible using a pre-emergence spray. The value of a pre-emergence treatment using either 2,4-D or MCPA in conjunction with either one or two subsequent cultivations, has been clearly demonstrated.[20,21] That this method of increasing yields and thereby improving the economy of maize production in the Union, has not been more readily accepted, is an indication of the need for extension work amongst farmers.

Pre-emergence weed control in maize

The limitations of traditional and chemical methods where applicable has been recently reviewed for the Union of South Africa.[11] It is really only in South Africa and the Rhodesias that pre-emergence chemical weed control has developed to any extent.

Pre-emergence control is usually practiced when the weed problem is such that post-emergence sprays do not adequately control the weed. This technique may also be used to control weeds susceptible to post-emergence spraying but due to the higher cost of pre-emergence treatments, the complex nature of the operation and the variability of results, broadleaved weed control is usually left to the easier post-emergence spraying. Pre-emergence spraying is practiced, therefore, when it is necessary to control the annual grass weeds, such as *Eleusine indica* and *Panicum laevifolium*.

The success or failure of a pre-emergence treatment depends on the retention of the herbicides in the weed seed soil layers. A successful treatment is one in which the herbicide is retained for a sufficiently long period to allow crop establishment without injuring that crop. Much depends therefore on the fate of the herbicide in the soil and F.6 is the most promising as its inert character prevents it from being leached from the soil.

The control of weeds in maize using chemicals, post emergence is fraught with difficulty. Maize must be regarded as a sensitive crop. In South Africa, Rhodesia, and East Africa, damage has occurred when sprays are applied to maize having more than six leaves. Except when snapping occurs there is no evidence that damage will affect the final yield of the crop, but nevertheless it is a phenomena to be avoided. Present recommendations are to apply the weedkiller before the 5-6 leaf stage of the crop, and subsequent sprays should be applied using drop arms. Similar results have been obtained in East Africa,[2] where it is found that most damage occurs when the maize is treated between 5″-12″ in height. Present recommendations in East Africa are to apply the weedkiller between the 2-4 stages.

The limitations which are imposed on post-emergence spraying restrict the aerial application of weedkiller to maize.

Other field crops

In South Africa potatoes, groundnuts and cowpeas are treated by means of pre-emergence sprays for the control of various weeds. The general principles applying to

pre-emergence weed control in maize applies to these crops as well.

AQUATIC WEEDS

Water Hyacinth

Virtually the only aquatic weed of serious importance in Africa today is water hyacinth—*Eichhornia crassipes;* an infestation of Salvinia has, however, been noted in East Africa.[27] Information on hyacinth is obtainable from recent publications.[23,24,25] Drawing on the work of these authors, a brief resume of the position will be given. Water hyacinth was first reported in the Belgian Congo in 1952.[26] By 1955, the situation was regarded seriously and it was decided in view of the potential danger that the matter would be best handled by CCTA/CSA. By doing so, several territories endangered have been placed on their guard and effective measures for the control of the pest were initiated.

Experimental work conducted in America showed that 2,4-D at the rate of 8 lbs. per acre successfully controlled the weed. A plan of action was drawn up for use in the Congo based 2,4-D amine. The original plan consisted of three phases—initial application; follow-up spray; and patrol maintenance. The initial sprays were applied from boats using power pumps. The results were spectacular and after two years the weed had practically disappeared over 500 km. near Stanleyville. The cost of this treatment was fantastic, particularly in view of the difficulties entailed in the application of the weedkiller itself. Not only have the river banks to be sprayed, but also the fringes of numerous islands which occur in the river.

In order to reduce the application costs, the use of helicopters has been investigated,[26] and this has been found satisfactory.

Infestations in other parts of Africa

Water hyacinth has been known for several years near Salisbury in Southern Rhodesia, in the Zwartkops River in Port Elizabeth, and is also present in Mozambique in the River Incomati. These infestations have not been serious and are being kept under control in a satisfactory manner.

References

[1]Shantz, R. L. and Marbut, L. F. The vegetation and soils of Africa. *American Geog. Society*, 1923.

[2]Rheinallt Jones, J. D. Human Resources. *Africa South of the Sahara.* South Afr. Inst. for Int. Affairs. Oxford University Press, 1951.

[3]Meredith, D. and T. D. Hall, Agricultural Production. *Africa South of the Sahara.* South Afr. Inst. for Int. Affairs. Oxford University Press, 1951.

[4]Phillips, John. Fire: its influence on biotic communities and physical factors in South and East Africa. *S.A. Jour. Science* 27 (1930).

[5]Ibid. Fire in vegetation: A bad master a good servant. *Jour. South Afr. Botany*, January; 1936.

[6]Ibid. Some important vegetation communities in the central province of Tanganyika Territory. *S.A. Jour. Science;* 26 December, 1929.

[7]West, O. Thornbush encroachment in relation to the management of veld grazing. *Rhod. Agr. Jour.* 44 488-497 (1947).

[8]Ibid. Bush encroachment, veld burning and grazing management. *Rhod. Agr. Jour.* 55 No. 4, 1958.

[9]van der Schyff, N. P. Bush encroachment in South Africa. *Report to S.A.N.C.C.U.S.*, Pretoria, February, 1956.

[10]Pienaar, A. J. *Private communication.* University of Pretoria, October, 1958.

[11]Hattingh, E. R. Weed problems and present control practices in South Africa. *African Weed Control Conference*, 1958.

[12]Cleghorn, W. B., McKay, A. D. and Cronin, C. H. Results of preliminary herbicide trials on a number of species limiting livestock carrying capacity of veld in Southern Rhodesia. *African Weed Control Conferance* 1958.

[13]Hattingh, E. R. Comments on thorn scrub control with herbicides in Africa. *Weeds*, 1, 4, 1952.

[14]Scott, J. D. The eradication of thorn trees. *Farming in Souih Afr.* 15; 422 (1940).

[15]Naude, C. P. and Sorfontein, J. Eradication of Lantana and Thorn Trees. *Farming in South Afr.* 31, 1956.

[16]Ivens, C. W. Some tree and scrub control problems in East Africa. *African Weed Control Conf.* 1958.

[17]Tas, R. N. INEAC Yangambi *Private Communication*, 1958.

[18]Fleming, S. D, Perennial grasses as limiting factor in tropical agriculture, and methods for their control. *African Weed Conference*, 1958.

[19]Ivens, C. W. Control of couch grasses in coffee. *African Weed Control Conference*, 1958.

[20]Altona, M. E. A preliminary report on the control of weeds in maize. *S.A. Journal of Science*, 46, 10; 1950.

[21]Altona, M. E. and Mentz, N. J. Weed control in maize with weedkillers. *S.A. Journal of Science*, 49, 11; 1953.

[22]Marais, J. N. *Private communication*, 1958. Dept. of Agr. Union of S. Africa.

[23]Lebrun, J. Present position of the problems of *Eichhornia crassipes* in Africa, South of the Sahara. *Agr. Bull. Belgian Congo*, LIX, February, 1958.

[24]Eichhornia crassipes. *CCTA/CSA Publication* No. 27, 1957.

[25]Kirkpartick, H. Eradication and control of water hyacinth. *World Crops*, August, 1958.

[26]Buyckx, K. J. E. and Tas, H. Studies in the control of water hyacinth using a tierbine helicopter.

[27]Burges, R. L. African Explosives and Chemical Industries (East Afr.) Ltd. *Private communication*, Oct. 1958.

"The role of SURFACE ACTIVE SUBSTANCES in the APPLICATION of PESTICIDES"

(*Report of an address by Dr. G. S. Hartley to a joint meeting of the Pesticides Group and the newly-formed Surface Activity Group of the Society of Chemical Industry.*)

Dr. Hartley described water as "an extremely unsociable liquid" and placed his emphasis on the extremity more than the unsociability. The physico-chemical properties such as the hydrogen bonding of water which make it the most self attracting of all substances with the exception of metals, also give it a greater attraction for a few types of atom or grouping and more often than not it has a more violent attraction to these substances than it has to itself. On the other hand these same physico-chemical properties cause it to shun more completely than any other liquid, any substance which it considers unattractive.

Why then, is water used so much, why is it used as a carrier for substances which are unattractive to it and require the necessity for surface active substances to prevent them being shunned by the water? The answer is simple, for the liquid state is by far the most convenient state for mechanical handling, and water is overwhelmingly the most abundant of liquids. "Even in industry," said Dr. Hartley, "where recovery and conservation are more possible than in domestic life or agriculture economics dictate the use of water, whenever possible, for purposes for which some other liquid would otherwise be more suitable."

The necessity for the use of water in agriculture is even greater for despite the fact that the amount of available water will vary from season to season and place to place, the economics of agriculture dictate, even more strongly in agriculture than in industry, that when a liquid is required it must be water whenever possible.

It is for these reasons that when talking of surface active compounds, Dr. Hartley confined himself exclusively to the subject of surface activity at the surface of water, that is at its boundary with air, another liquid or a solid.

Perhaps the first surface active compounds were the natural soaps, consisting of a long straight paraffin chain, longer than C16, and a hydrophylic group usually an alkaline earth metal. These materials will of course congregate at the surface of water with the hydrophilic group being held in the water and the hydrophobic paraffin group being repulsed from the water.

The result of this is that for each hydrophylic group held in the water there is a corresponding paraffin chain projecting at right angles to the water phase and into another phase such as oil or grease or some organic group to which it is attracted. If there is no other phase with the exception of air, then other factors such as gravity and available surface will come into play. It is obvious that these long carbon chains will not project straight up into the air, they will in fact crumple or if they are pushed into the body of the water by a restricted available surface these hydrophobic groups will tend to aggregate. This aggregation although antagonistic to the surface active properties will however increase the solubility and thus allow a higher concentration to be obtained.

Since the first use of these long straight paraffin chains of vital origin, there has been the tendency to use cheaper short chains from the petroleum industry. These cheaper short chains are sometimes branched and have numerous synthetic bridges. However, they will not form as high concentrations as the natural straight chain paraffins as the branches will not allow as much crystal packing when they aggregate in the bulk of the solution.

Apart from economics there are other objectives in improvements on natural soaps. The insolubility of the calcium salts of the natural soaps creates difficulties in hard water, natural soaps are also inactive in acids and this can create problems especially to the dyestuffs industry. In agriculture where the available water will vary in hardness and acidity from area to area these two factors alone can create serious difficulties. There has been a tendency therefore to use paraffin groups from the petroleum industry as the Calcium salts are more soluble, and also a tendency to replace the alkaline earth hydrophylic group with a non-electrolytic group such as an ester often sulphate esters. The effect of the replacements is to produce less variations with different types of water and the advantages of this in agriculture, where there is no possibility of technical control of the water, is obvious.

Another aspect which has not so far been stressed in the use of these shorter chained, branched paraffins is that because of their geometry they tend to disperse more than straight chain compounds, and can therefore be advantageously used as wetting agents, " spreaders " and in Aerosols; unfortunately this apparent advantage in spreading is somewhat nullified by the fact that the easier they are dispersed there is a corresponding difficulty in obtaining concentrated solutions. Some measure of the importance of this can be realised from the fact that it takes 160 litres of a 1 % solution to form a monolayer over 4 acres of leaf and 4 or more acres of leaf are equivalent to one acre of land.

The necessity for the use of water as a carrier has been mentioned and another factor to take into consideration is that if water were not used the quantity of material to be used would in general too small to be be handled efficiently. As water is required so are Surface Active Compounds so that Emulsions, Suspensions, wettable powders, etc., can be formed from insoluble pesticides. These surface active compounds are also needed as wetting agents and spreaders, so that the water carrying the pesticide will spread over a wider area, thus giving a wider and more even spread of the pesticide.

There are of course several problems in agriculture which have yet to be solved, for instance there have been a number of cases of leaf scorch and other damage by weedkillers and insecticides and this damage only occurs when a wetting agent is used. More research is required into the surface structure of leaves for hairs and waxy blooms on leaves can create an unwettable surface due to their structure alone; if as well as the hairs which hold the water away from the actual surface of the leaf the plant has an " unwettable " surface due to its chemical constitution, we have a serious problem indeed.

Another problem is the fact that in general the more finely a compound is spread, the less resistant it is to decomposition so that, a compromise between finer spreading and persistency, must be made.

Another problem is that surface active compounds make a froth and this creates problems for the chemical engineers.

In conclusion one can state that the impression gained was that if Dr. Hartley had not been restricted by the time factor he could have greatly amplified this interesting account of Surface Active substances.

Two events of particular importance occuried in March: a press visit to Farbenfabriken Bayer at Leversuken; and a demonstration of several different types of aircraft by Fisons Pest Control Limited.

" P.T." was represented at both these events and full reports will appear in our May issue.

"No ill effects on appearance, yield, earliness or quality . . . ."

ANNUAL WEED CONTROL IN ESTABLISHED ASPARAGUS WITH MONURON

By H. A. Roberts,

National Vegetable Research Station, Wellesbourne, Warwick.

Synopsis

Monuron was applied at rates of 2 and 4 lb. per acre to established beds of asparagus in the spring, before spear emergence, and excellent control of the majority of annual weed species was obtained. No adverse effects on crop yield or quality could be detected after four successive annual applications at these rates. Tests indicated that there was no risk of build-up of monuron in the soil provided that not more than 2 lb. per acre was applied in any one year, but after a spring application of 4 lb. per acre sufficient was present a year later to affect the growth of a sensitive test crop. It is concluded that monuron at 2 lb. per acre is a safe and satisfactory treatment for annual weed control in established asparagus beds.

Introduction

In the raised bed system of asparagus culture, weeds have traditionally been controlled by hand labour, although some growers have used calcium cyanamide or sulphuric acid and other contact herbicides to keep the beds free from weeds during the cutting season. In 1953, successful tests with asparagus were reported in the U.S.A. in which monuron was used as a residual herbicide,[1] and it was felt that this chemical might prove useful under British conditions. Experiments were begun at the N.V.R.S. in 1954, and a preliminary account of the results has already appeared.[2]

Experimental

Asparagus was grown in single-row beds and the experiments were of randomised block design with from four to six replicates of each treatment. An 80% wettable powder formulation of monuron was used and all rates are given as pounds per acre of active ingredient. The sprays were applied in spring, after the beds had been finally worked but before the first spears emerged, at a volume of 100 gal. per acre of actual bed sprayed. Cutting and winter cultivation were carried out according to the normal methods used in the Vale of Evesham.

Discussion

It has been shown previously that on a sandy loam, only very low rates of application of monuron are required to give control of many species of annual weeds, but that certain others will withstand the application of 2 lb. per acre.[3] In the present experiments, both rates of application were sufficient to keep the beds free from most species for a period of several months. It is clear, however, that the tolerant species could rapidly increase if not removed by other means. Established perennial weeds such as *Convolvulus arvensis* and *Cirsium arvense* were not affected by monuron at rates up to 4 lb. per acre in these experiments, but with *Agropyron repens* some control was achieved when the rhizomes were close to the surface.

No ill effects on appearance, yield, earliness or quality were detectable in asparagus that had been treated with 4 lb. per acre of monuron annually for four years. Rahn[4] reported similar absence of injury in a crop that received a total of 18 lb. per acre over a three year period. There would also appear to be no adverse effect on flavour, and recent work in the U.S.A.[5] revealed no flavour differences in canned and frozen samples from untreated plots and those treated with relatively high rates of monuron for a period of more than four years.

The present tests indicate that there is no risk of phytotoxic concentrations of monuron building up in the soil as a result of annual applications of 2 lb. per acre, a conclusion which is in agreement with that from work carried out in the U.S.A.[6,7,8] Even with an annual application of 4 lb. per acre, the risk of such build-up would appear to be slight, although sufficient monuron to affect the growth of susceptible test plants was found to be present a year after treatment with this rate. It is suggested, however, that beds in their final year should not be sprayed, otherwise there would be a definite risk of injury to other crops planted soon after grubbing.

Since the publication of the earlier report,[2] the spring application of 2 lb. per acre of monuron for annual weed control in established asparagus has been adopted by growers in the Vale of Evesham and elsewhere, with generally satisfactory results and appreciable saving in labour costs. There is, however, a need for alternative sprays for use in those instances where the annual species that are tolerant to monuron show a tendency to increase, and for this purpose CIPC and simazin would seem to show some promise.

References

[1] Carlson, R. F., Grigsby, B. H. and Carolus, R. L. *Quart. Bull. Mich. agric. Exp. Sta.*, 1953, 36, 163.

[2] Roberts, H. A. *Grower*, 1955, 44, 1349.

[3] Roberts, H. A. *J. Hort. Sci.*, 1957, 32, 142.

[4] Rahn, E. M. *Tech. Bull. Del. agric. Exp. Sta.*, 1954, 303.

[5] Ellison, J. H., Aldrich, R. J., Rahn, E. M. and Maclin, W. A. *Proc. 11th Noeast. Weed Control. Conf.*, 1957, 83.

[6] Hill, G. D., McGahen, J. W., Baker, H. M., Finnerty, D. W. and Bingeman, C. W. *Agron. J.*, 1955, 47, 93.

[7] Lillie, D. T. and Aldrich, R. J. *N.J. Agric.*, 1956, 38(4), 10.

[8] Baynard, R. E., Rahn, E. M. and Somers, G. F. *Proc. 11th Noeast. Weed Control Conf.*, 1957, 23.

Midge Control in Scotland*

By Dr. D. S. KETTLE, D.Sc. (Lond.). *and* R. H. PARISH, B.Sc.

Department of Zoology, The Ashworth Laboratory, West Mains Road, Edinburgh, 9.

Part I

Introduction

SINCE 1945 a good deal of attention has been paid to biting midges in Scotland. At the start the entomologists of the four Scottish Universities made a survey of the midge problem in relation to man. They found that nearly all the human irritation was due to one species *Culicoides impunctatus*. Another half dozen species may prove to be locally important, for example *halophilus* in coastal areas but most of the twenty five or so species of *Culicoides* in Scotland ignore man completely.

Impunctatus was restricted to bogland breeding sites in association with the bogmoss *Sphagnum*. Since *impunctatus* spends most of its life as a larva in the breeding site, this observation held out the promise of midge eradication at the source by destroying the larvae in the breeding site.

Work in the early years indicated that the flight range of *impunctatus* through wood was very limited and at the time it seemed that here was the basis of a rational control scheme. If *impunctatus* larvae could be eliminated from all breeding sites within two hundred yards of a location then, in theory at least, that location should be protected from midges. It seemed as though it would be possible for individuals to deal with their own midge nuisance.

In 1953 the Midge Control Unit was formed to investigate the practical possibilities of this suggestion and the first task was to find a suitable method of eliminating *impunctatus* larvae from breeding sites. To find the best larvicide for this purpose a series of field tests were conducted and two experimental sites were selected.

Site one was used for a detailed comparison of DDT and BHC. The comparison was between equal quantities of active ingredient, that is between the para para isomer of DDT and the gamma isomer of BHC and not between commercial DDT and BHC.

Four different preparations were to be compared — a wettable powder, a water miscible concentrate, a dust and an oil solution. A preliminary trial to give an indication of dosage produced conflicting results and so four dosages were selected to give a wide range which would cover all practical rates of application. Each preparation was therefore applied at 3, 12, 50 and 200 milligram active ingredient per square foot, except for BHC dust which was applied at 3, 6, 12 and 25 milligram gamma isomer per square foot because the available dust contained only one half per cent. gamma and very large quantities would have had to have been applied to provide the higher dosages. 10 milligram per square foot is approximately equal to one pound per acre so that the dosage ranged from one third to twenty pounds para para DDT or gamma BHC per acre. Treatments were allocated at random except that similar DDT and BHC treatments were placed together. Five untreated plots were incorporated in the design to follow changes in the untreated larval population.

Sampling

The plots were sampled in the autumn of 1953, sprayed just before Christmas and resampled monthly in the first four months of 1954. The control achieved was expressed as a percentage of the pre-treatment density after allowing for changes in the larval population of the untreated plots. Somewhat surprisingly two-thirds of the plots showed increased larval densities. These included all the untreated plots, three quarters of the BHC plots and half the DDT treated plots. This increase is not due to larvae being repelled from the treated plots.

DDT wettable powder and miscible oil achieve moderate immediate larval control. The dust and oil solution are ineffective. Indeed the lowest concentration of oil attained the highest control. Gamma BHC gives

similar results except that the miscible oil is ineffective in the middle dosages. Considering the rate of application the results are disappointing, few reached seventy five per cent. and none gave complete control.

The plots were resampled in the autumn of 1954 after a season of adult activity and oviposition. The results are much more encouraging. All the DDT treatments except the lowest attain satisfactory degrees of control. The application of para para DDT as a wettable powder, miscible oil or dust at twelve milligrams or more per square foot achieved over ninety per cent. control. The oil solution continues to give anomalous results possibly due to the difficulty of an oil penetrating saturated peat. There is little doubt also of the superiority of para para DDT over gamma BHC as a larvicide for *impunctatus*. The DDT product is consistently more effective than its BHC counterpart.

In view of the fact that DDT wettable powder is the cheapest of the preparations and that it produced seventy per cent. control at three milligrams per square foot it was decided to use this product in the full scale trials.

No further observations were made on the oil solution or the BHC dust. Two years after application, the two highest dosages of the other three DDT preparations were resampled and five of the six now gave complete control and only one larva was recovered from the plots where ninety were expected.

Three years after application the top three dosages of the same three preparations were again resampled and eight of the nine were still completely successful and only two larvae were recovered in place of the one hundred and twenty three expected. Once the initial period has passed DDT exerts complete control for at least three years. Over the same period there were signs that BHC was losing its effect.

Site two was used to evaluate a number of other insecticides. Aldrin dieldrin and malathion were applied as wettable powders, as were DDT and BHC which were included for comparison with site one. Chlordane and malathion were applied as miscible oils. The dosages varied from three to fifty milligrams per square foot.

All the treatments achieved some reduction in larval density. Malathion gives the highest immediate kill, aldrin and chlordane are next but none of the kills are adequate and few exceed fifty per cent. One curious feature is the way the kill appears to be independent of of the dosage applied. Thus an increase of sixteen times in the dosage of malathion—from three to fifty milligrams—produced no more control. This is true for all insecticides. It indicates that the factor limiting larval kill is not the dosage of insecticide.

Re-Sampling

After a full season of adult activity the plots were resampled at the end of 1954 and early 1955. Both preparations of malathion were less effective than earlier but all the others had improved considerably. Dieldrin at 25 milligrams per square foot and DDT and BHC at fifty milligrams gave over ninety per cent. control. DDT at twelve milligrams was not as effective as on site one. The highest dosages of dieldrin, chlordane, DDT and BHC were sampled a year later and all gave control—only chlordane with eighty five per cent. failed to give complete control.

Three years after application all the treatments of these four insecticides were resampled. All except the lowest dosages of dieldrin and chlordane had continued to improve. Dieldrin at twelve and twenty five milligrams and chlordane at fifty milligrams gave complete control. DDT at fifty milligrams also gave one hundred per cent. control but the lower dosage, twelve milligrams remained relatively ineffective giving only twenty two per cent. control. As on site one both BHC preparations had become less effective three years after application.

The prolonged larvicidal action of these insecticides is most encouraging because it means that treatment will only need to be repeated after several years, which will substantially reduce the cost control per annum. Altern-

atively it implies that treatment need not be completed at one time. The treated area can be extended as opportunity occurs. At present the maximum period of this residual action is not known, but it must be at least three years.

Considerations

Let us now consider the explanation of the long delay between larvicidal application and the attainment of larval control. In all of these trials the immediate larval kill, that is after a month or more, was low compared with that reached after six months.

Comparisons between annual rainfall and the percentage of control shows that there is good evidence for relating the delayed action to rainfall.

The larvae of *impunctatus* live in the upper two inches of peat under a layer of living moss which may be six inches thick. Applied larvicides will be retained on this living layer and will only slowly be carried down to the peat where they can make contact with the larvae. Clearly a lot of water will be required to achieve this movement of the insecticide particles. It appears that about twenty inches of rain per annum will be required to attain satisfactory control.

Rainfall then would be the factor, which more than dosage, limits the amount of control achieved by an insecticide. In practical terms it means that larvicides applied in the spring are unlikely to reduce the midge population in the succeeding summer unless the adults acquire a lethal dose as they leave the peat. Therefore the best time for larval spraying is the autumn when the winter rains will wash the larvicide into the peat. On the other hand it might prove difficult to persuade people that the best time to spray is when the midge season is over.

Larval density

Let us now consider the increase in larval density which occurred in the untreated plots of site one after spraying. There is evidence to prove that neither repellency by the insecticide nor delayed hatching can offer a satisfactory explanation.

An analysis of pretreatment data indicated significant differences between plots, which was not a surprise, however, there were also significant differences between the pretreatment sampling occasions and this was not expected.

It was important to know whether this was a natural phenomenon or due to the erratic behaviour of a few plots. To test this, plots were arbitrarily grouped on the basis of their subsequent treatments.

It was found that the larval numbers tend to rise and fall in unison in all groups.

Where do the larvae go when the population is apparently reduced and where do they come from when the populations appears to increase? Sampling of the plots was not completely randomised but at random throughout the zone regarded as suitable for breeding. If in response to some changing factor the larvae moved away from the suitable zone then the population would appear to decrease.

The frequency and widespread nature of the fluctuations suggests that the factor involved is commonly encountered. One possible candidate is the soil water level. As the level falls or rises the larvae would tend to move into zones previously regarded as too wet or too dry and move out of the sampled zone. On uneven bogland a small lateral movement would enable the larvae to maintain their position relative to the surface and the soil water.

The existence of large natural fluctuations in populations are adequate to explain the apparent increase in larval population after spraying. It also emphasises the need for incorporating untreated plots as a check on natural changes, and clearly these changes must be taken into account when assessing the control achieved.

Part II

FULL SCALE FIELD EXPERIMENTS

A. Talladale Experiment

1. Introduction

From the previous paper it will be seen that midge control was becoming a practical proposition. The conclusions showed:

(i) that midges did not fly much more than 150 yards from their breeding sites and

(ii) that modern insecticides applied at reasonable dosage to the breeding grounds would kill the larvae.

Other field observations showed that midge flight activity was stopped by gentle breezes, so there was no chance of them being blown into controlled areas.

The best approach seemed to be to select an area where midges were troublesome, spray all the breeding sites and then estimate the number of adult females by sticky traps.

2. Arrangement of Site and Area of Treatment

A suitable experimental area was found at Talladale and this was divided into three sites, A, B and C.

On all sites the sticky traps were arranged on a grid system with 50 yard intervals, and a central trap was used to indicate the protected point.

As it should be possible to achieve 99 per cent. control by treating all breeding grounds within 150 yards of the place requiring protection, it was decided to treat all the midge breeding grounds in a belt 125 yards around the central trap on site A and 175 yards around the central trap on site B. Site C was left untreated as a check upon the natural population fluctuation of the midges.

3. Insecticide

(i) *Formulation*

DDT wettable powder proved an efficient larvicide in the Soutra experiments and so site B was treated with this insecticide formulation.

It was possible that if successful this technique might be used by unskilled personnel who did not wish to purchase spraying equipment. DDT dust appeared to be a suitable alternative here and it was applied to site A.

(ii) *Dosage*

The dosage of insecticide was determined by previous work but in large experiments care must be taken not to exceed toxic limits. Frequently areas of Scotland which support high numbers of midges are used for grazing cattle and sheep, so it is not desirable to greatly exceed 5 lbs./acre.

(iii) *Method of application*

In the Soutra experiments, treatment was applied in spray volumes of 80 gal./acre. Although this volume was inconveniently large it was applied to site B using a Dorman mechanised sprayer for fear the initial spray volume might influence the control achieved.

A simple duster was designed to apply DDT dust to site A because this was the treatment most likely to be used by unskilled people.

4. Results

To illustrate the control achieved traps were grouped according to their distance from untreated areas. The mean weekly number of *C. impunctatus* captured in each group in 1955 and 1956 was then expressed as a percentage difference of their 1954 pretreatment value.

In 1955 site A showed a general increase of 61 per cent. Traps 50, 100 and 125 yards from the untreated area recorded increases of 65, 56 and 26 per cent. respectively. It is therefore evident that the control technique did not decrease the actual numbers of midges at the centre but it may be argued that it prevented them increasing in the same proportion as the outer traps.

In the same year site B showed a general increase of 3 per cent. but this was more encouraging because 21 and 6 per cent. reductions occurred on traps 175 and 150 yards respectively from the untreated area. The remaining traps at 100 yards and at 50 yards showed increases of 3 and 7 per cent.

Although little control was achieved the figures demonstrate that it became progressively more efficient nearer the centre of the treated area. That is, a regression of females across the treated area was discernible.

In the absence of control one would expect an irregular increase throughout the trap groups as recorded on the untreated site C.

The trap records for 1956 showed that the control achieved on site A in 1955 failed to persist.

On site B a general decrease of 12 per cent. was recorded. All trap groups on this site caught fewer midges, with the greatest reductions, both of 26 per cent. occurring at the centre. This reduction decreased on outer traps nearer the untreated area to 16 per cent. at 100 yards and 6 per cent. at 50 yards.

Site C recorded an increase of 2 per cent. The largest increment occurred at the centre and decreased towards the outer groups, which is the opposite of the midge distribution on site B.

These results show that DDT wettable powder and dust applied at 5 lbs./acre commenced to produce a discernible control effect in 1955, but only the wettable powder exerted control in 1956. It thus appeared that the insecticidal action of the dust was stopped, while that of the wettable powder was severely reduced before it could kill an appreciable number of the larvae destined to become adults in 1956.

5. Failure of Control

Failure of control cannot be attributed to resistance, inadequate distribution of insecticide, lack of rainfall, unsuitable temperature and acidity, absorption by vegetation or destruction by sunlight. However some insecticide may have been adsorbed by the peat during the prolonged warm and dry period and later humid conditions may have had a detrimental effect upon the dust applied to site A.

B. Experiments around Human Habitations

Although the Talladale experiment was not a success it demonstrated some of the problems facing future control work.

(i) It showed that the spray volume of 80 gal./acre should be considerably reduced.

(ii) The difficulties encountered in taking mechanised sprayers across midge breeding sites indicated that pressurised knapsack sprayers would probably be more suitable for future work.

(iii) It also drew attention to the fact that certain traps captured many more female midges than others. These high captures were found to be associated with animal or human activity. This led to the important conclusion that future control experiments should be conducted around human habitations to investigate the effect of hosts upon the activity of female midges.

(iv) It again drew attention to the necessity of spraying in the autumn to achieve control the following summer. Although this time lag is not important, except where control is desired immediately

after treatment, it raised the possibility of achieving immediate control by increasing the dosage or by using quicker acting insecticides.

With these problems in mind the technique was given further field trials in the spring of 1956. Eight experimental areas were selected in various parts of Scotland. Each had a human habitation to provide a centre of attraction. The degree of attraction varied from a single house at Glen More to an entire village at Carsphairn.

1. Arrangement of sites and trapping stations

The major considerations regarding flight range, area of treatment and insecticides etc. in these experiments were similar to those at Talladale.

Sticky traps were used to show the effect of treatment but the number and arrangement differed from that at Talladale.

The traps placed outside the treated area indicated the natural fluctuations of *Culicoides impunctatus*.

2. Treatment

Small plot experiments conducted after the Talladale spraying indicated that the initial spray volume was not important provided adequate coverage was obtained. With modern nozzles and spraying equipment excellent coverage may be obtained at 5 gal./acre. However, since a good " run off " from the ground vegetation was desired treatment was applied at 15 gal./acre.

(i) *Insecticide formulation and dosage*

Three sites (Cluanie, Achray and Carsphairn) were treated with 50 per cent. technical DDT wettable powder at 5 lbs. active ingredient per acre. Two (Sligachan A and Strachur) received treatment with 50 per cent. technical BHC wettable powder at 5 lbs.γBHC/acre and another (Scourie) with Dieldrin water miscible concentrate at 1¼ lbs. active ingredient per acre. In an attempt to achieve control immediately after spraying the dosage of DDT was increased fourfold to 20 lbs./acre at one site (Glen More) and a new insecticide formulation " Hexagerm " (a BHC preparation of The Standardised Disinfectants Co. Ltd.) was applied at 5 lbs./acre to another (Sligachan B). " Hexagerm " appeared to have the qualities required by a quick acting larvicide for in simple laboratory tests it killed *Culicoides* larvae quicker than other preparations under similar conditions.

3. Results

The control achieved at each site was based upon two seasons' observations of midge activity.

(i) *Immediate control*

It was hoped to achieve control immediately after treatment by increasing the dosage or using quicker acting insecticides. However, after treatment with " Hexagerm " the treated traps captured more midges than the untreated (3,703 cf., 1,524), also increasing the dosage of DDT failed to produce immediate control.

(ii) *Control one year after treatment*

The best control one year after treatment was achieved by DDT at Carsphairn (58 per cent.) followed by BHC at Strachur (44 per cent.) and BHC at Sligachan A (21 per cent.). There was no control at Glen More and Cluanie.

Grouped data shows that fewer females were captured on treated traps in the second year (14,510 cf., 15,267). Although of limited practical importance this reduction was encouraging, because the untreated traps increased by 29 per cent. in this period (10,906 cf., 15,267).

It was therefore apparent that practical midge control was not achieved in these experiments. Furthermore, it is concluded that this failure cannot be attributed to a natural resistance of *Culicoides impunctatus* to modern insecticides; insufficient rainfall to distribute the insecticide throughourt the peat; destuction of the insecticide by summer temperatures and sunshine; acidity and humidity at the breeding grounds; absorption of the insecticide into the vegetation or absorption of the insecticide by peat.

One possible explanation is that the females fly further than originally anticipated.

When the captures from traps around human habitations are compared with those from untreated areas, they show an increase of 54 per cent. (29,777 cf., 19,342). This increase is believed to be a direct response to the presence of suitable hosts and therefore does not represent dense midge breeding in the vicinity of the treated traps. Adequate control had previously been achieved by many workers when the control exerted was based upon larval and not adult counts. Therefore, it seems reasonable to assume that the larvae in the treated area were killed but the expected reduction of adult females failed to occur because they flew from the untreated into the treated area.

An indication of the distance flown by the females may be obtained by observing the overall control exerted by all treatments at all sites. Traps placed 150 yards from the untreated area exerted 26 per cent. control. If this value is plotted against the distance and the graph extended to 100 per cent. control (the base line) an intersection occurs at 575 yards, which suggests midges may fly this distance to obtain a blood meal.

Now this observation requires some qualification.

It is not suggested that midges can perceive and reach moving hosts, such as man or beast 575 yards away. This is clearly impracticable because midges are slow fliers and the host may move away quicker than the insect flies towards it. However, where the attraction is static, such

as a human habitation, the females may move towards it over a period of time. This interpretation does not require sustained or rapid flight by *Culicoides impunctatus* and agrees with the small size of the insect.

It is believed that the females are fertilised on, or soon after, emergence and then as a result of this stimulus commence to fly about to seek a blood meal. If in this flight the insect passes close to a suitable host it will presumably fly directly towards that host. The distance at which host perception and direct flight takes place is unknown, but it is not thought to be much more than 25 yards. In the absence of a suitable host the search continues and the insect may move approximately 600 yards from the breeding site. This would account for the failure of control measures extended 150 yards around the location to be protected.

Part III

Further Trials

Early in 1957 it became clear that another estimate of the flight range of *impunctatus* was required. Ideally one would like to find a circular breeding site surrounded by well drained land on which no breeding could occur. Dispersion could then be measured from the breeding site in all directions. Alternatively one could use a breeding site with clearly defined limits. Since we are interested in maximum flight range this clear cut edge would need to be at right angles to the prevailing wind. Such conditions are difficult to realise in practice.

A reasonably suitable area was found on Brunston Muir, eleven miles south east of Edinburgh. Exhaustive and careful trials were made at this site, taking into consideration the meteorlogical conditions, the presence of wind breaks and animal and human hosts, both permanent and temporary. The most significant point indicated by the trials was that adult distribution is more dependent on food supply than on distance from the breeding site. This fact also applied to the males although they do not require hosts for food.

It was apparent that these experiments have failed to answer the question with which we began. How far will midges fly with the aid of the wind? In fact one might doubt whether this can be answered at all unless the distribution of suitable hosts is also specified. Certainly they go a half to three quarters of a mile without statistically detectable loss. This is so far that we are left wondering how the control experiments managed to produce even twenty five per cent. reduction. This will depend on the abundance of breeding sites outside the sprayed area. Where they are scarce some control will be achieved but where they are abundant almost no control will be obtained.

Responsibility

From the meteorological records available there is a suggestion that during these experiments the winds were more easterly than usual. Therefore it cannot be assumed that dispersion was less in other directions. No longer can we think in terms of an individual dealing with his own midge problem by treating the nearby breeding sites. He will still be invaded by midges breeding on someone else's land. This greater dispersion removes midge control from the sphere of individual action and hands it over to the community. There is no reason why midge control should not be the responsibility of the public health authorities. It is true that midges do not transmit any human disease but neither does the bedbug and yet it is controlled by the public health services. Shouldn't the midge be regarded as the rural counterpart of the urban bedbug?

The increased flight range will increase the cost of control but this is counteracted to some extent by the prolonged persistence of larvicide in peat. This is a considerable advantage because it will enable control measures to be extended in the light of experience without the necessity of respraying the whole area.

Observations

Let us consider briefly the observations on the males. They appear to be responding to the presence of a host like the females. They may of course be responding to the females which in turn are responding to the host.

Two types of sexual behaviour have been described in *Culicoides*. In one the males swarm over fixed markers, oscillating to and fro. Males so engaged will only be trapped on their way to and from the swarm and male catches will be low. For example, *pulicaris* males swarm and in these experiments the sex ratio for *pulicaris* was one male to fifteen females compared with one to two for *impunctatus*. In the other pattern of behaviour mating occurs on the host while the female is sucking blood. In this case the males will need to disperse as widely as the females and to seek out hosts in the same way. Males will then be caught relatively frequently. *Impunctatus* males have never been observed on a host but their response to a host may serve to bring the sexes together in it's vicinity.

If these two patterns of behaviour exist in various proportions in different populations it would explain the varied sex ratio found in *impunctatus* by the same technique. Thus on Loch Lomondside males formed fifty eight per cent. of the catch. Here they form thirty six per cent. and at Talladale about twenty per cent.

---

* *Abstract of Communication to Associaton of Applied Biologists, Friday, 9th January, 1959*

" . . . there seems no reason why SMCA should not be developed for use on other brassica crops . . . . "

WEED CONTROL IN VARIOUS FODDER AND VEGETABLE CROPS WITH SODIUM MONOCHLOROACETATE.

By R. H. Hirst and D. L. Martin,
Plant Protection Ltd.,
Fernhurst Research Station.

Synopsis

Sodium monochloroacetate (SMCA) was found to control many weeds in kale and in some other brassicae without undue damage to the crop. Its performance and action were similar to sulphuric acid, without damaging the crop to the same extent, and it was much safer to handle. This chemical, of low mammalian toxicity, could be safely applied through a farmer's equipment.

SMCA, being a contact weedkiller, is not rainfast, but 12 hours dry weather after application was sufficient for susceptible plants to absorb a lethal dose.

There was little to choose between high, medium and low volume applications. High volume, however, was not so consistent as medium and low volume, but there was a tendency to higher yields though with slightly less weed control.

Introduction

In 1954, it was observed that sodium monochloroacetate (SMCA), a relatively non-toxic chemical, showed a certain amount of selectivity when sprayed on kale. A limited experimental programme in 1955 confirmed this. During 1956 and 1957 much more extensive trials were carried out and, although preliminary observations in 1956 were rather discouraging, the check to crop growth being more than had been expected, the final results showed yield increases and considerable reduction in weed populations. During the last three years experiments have also been carried out on a range of other horticultural crops. Promising results have been recorded on many of the brassicae, leeks and onions. Crop toxicity has been observed on carrots, peas, beet and lettuce when sprayed after they have emerged. Some experiments with SMCA as a pre-emergence weedkiller were also carried out; in these, damage was recorded on carrots.

Preliminary work was carried out in parallel with the use of SMCA in cereals reported at the British Weed Control Conference in 1956.[1]

Results

In October, 1954, it had been reported that SMCA controlled mustard in established kale with only slight damage to the crop. In the spring of 1955 trials comparing 10, 15, 20 and 25 lb. of SMCA in 20 and 100 gal./acre were laid down on seedling kale (2-3 leaf stage). The kale was severely scorched and vigour was reduced when compared with hand weeded plots. In the summer of 1955 a further series of trials on more advanced kale (9-24 inches) were laid down, the results may be summarised as follows:

1. There was considerable leaf scorch with 20 and 25 lb. SMCA especially at high volume, but all visible signs of damage disappeared in about three weeks.
2. Damage was increased by the addition of a wetting agent especially at high volume.
3. Volume of application made little difference in the amount of damage or weed control.

In 1956 a much more comprehensive series of trials was laid down, including chemical comparisons, volume and stage of growth trials and investigations into the effects of wetting agents. The results may be summarised as follows:

1. Kale was killed at the cotyledon stage, and at later stages of growth the cotyledons were always dessicated.
2. The optimum time to spray kale appeared to be when the crop had from 2-5 leaves. Kale sprayed at this stage of growth received a check which was no longer apparent 6 weeks after treatment. After the fifth leaf stage, damage increased as the leaf area increased and the leaves became more nearly horizontal and were therefore, able to retain more of the spray solution.
3. The addition of a wetting agent at all volumes and rates increased the amount of scorch to the crop. There was slightly more scorch and check to growth following spraying at 20 gal. than at 40 or 100 gal. 100 gallons was more erratic in its effects on weeds.
4. SMCA was less damaging to the crop than sulphuric acid but only slightly inferior in weed-killing ability. Whilst sodium and potassium cyanate were less damaging to the kale than SMCA, they were also more variable in their effect on weeds.
5. The optimum rate of SMCA was 20 lb. applied in 40 gallons spray per acre. It was considerably more pleasant to handle than sulphuric acid. If the crop had suffered any physical damage (from wind, cultivation, insects, etc.) the amount of damage following application of SMCA was increased.

In 1957 the trials were designed to give further information on volume comparisons and to assess the efficiency of one concentration, 1 lb. SMCA per gallon of water applied at 15, 20 and 25 gallons per acre. In all these trials particular attention was paid to the speed of recovery of the crop, and yield data were taken from six trials. The results are summarised below:

1. It was conclusively shown that 20 lb. SMCA could be safely sprayed on marrow-stem kale at the 1-5 leaf stage of growth in a minimum of 20 gallons of water/acre. Thousand-headed kale was severely damaged and some plants were killed when the crop was sprayed at the 1 leaf stage. Spraying after the second leaf had expanded produced no more damage than a slight initial check to growth.
2. Kale (marrow-stem, thousand-headed and Hungry Gap) was in all trials initially checked in growth. In one trial fresh weight samples were taken at weekly intervals following

spraying with 20 lb. SMCA in 20 gallons. Fresh weights were between 20% and 30% lower than in the controls one week after treatment at all growth stages (2-3 leaf, 3-4 leaf and 4-5 leaf). Three weeks after spraying all treated plots showed weight increases when compared with untreated plots. In the remaining trials no check to growth was visible four weeks after spraying.

3. In six trials small samples were weighed from each plot. In the volume comparison trials the greatest yield increase was recorded following spraying at 100 gallons per acre. In the trials where the 1 lb. SMCA per gallon concentration was sprayed at 15, 20 and 25 gallons an acre the greatest yield increase followed early spraying at the 1-3 leaf stage, there was no difference between rates of application.
4. One trial sprayed in a shade temperature of over 80°F. suffered much more damage than was seen in any other trial.

In 1958, a limited number of trials were laid down to increase the information available on the effects of volume of application with respect to yield. No yield data are yet available. Initial observations confirm previous results. In one trial where the 20 lb. in 40 gallons was applied through the same jets as the 20 lb. in 20 gallons, but travelling at half the speed, damage to the crop was strikingly increased.

Results on a range of vegetable crops treated over the last few years may be summarised as follows:

1. *Spring Cabbage* has proved very tolerant of 20 lb. SMCA sprayed at low or high volume. Twenty trials have shown that 3-5 leaves is the best growth stage at which to spray, though spraying 7-10 days after planting out is equally as safe. In only one trial has extensive damage occurred on the crop and in this trial, frost followed treatment.
2. Two trials on each of *cabbage*, *savoy* and *Brussel sprouts* have shown that these crops are tolerant of 20 lb. SMCA applied low or high volume at the 3-5 leaf stage. Sprouts were especially rapid in their recovery from the slight initial check.
3. Preliminary observations on *cauliflowers* had suggested that some varieties were severely damaged. A detailed trial on nine varieites showed that only two, Snow Queen and Le Cerf, were significantly damaged by 20 lb. SMCA in 20 gallons water.
4. *Swedes* were checked in growth when treated with 20 lb. SMCA in 20 gallons of water per acre after the 4 true leaf stage (but rapidly recovered). Earlier treatment caused severe damage and some deaths in the crop.
5. *Onions* and *Leeks* in trials over three years suffered severe damage at the crook stage, but were unharmed when treated from the post crook stage to the 3-4 leaf stage by rates up to 30 lb. SMCA at all volumes.
6. *Turnips* were severely damaged, or killed when sprayed before the 7 leaf stage with 20 lb. SMCA. After this stage there was a check to growth and severe leaf scorch.
7. *Beet*, *carrots*, *lettuce* and *peas* have all been severely damaged by post-emergence treatments of SMCA. Carrots have been damaged by pre-emergence applications of 20 lb. SMCA and by post-emergence applications as low as 5 lb.

Weed Control

When kale is sprayed at the optimum stage, i.e. 1-2 leaf for marrow stem, 2-3 leaf for thousand-headed, weeds are usually at the cotyledon or small seedling stage and are at their most susceptible. When spraying is done at later stages of growth on kale or other brassicae and at the post-crook stage of onions and leeks, weeds are usually larger and more resistant. It is unwise to delay spraying after the suggested stages of growth as weeds become more resistant as they grow older. Furthermore, the weed competition may already have reduced the crop yield.

Discussion

Below 20 lb. SMCA/acre the weed control was not consistently satisfactory, good results, however, were recorded at 15 lb./acre on charlock, *Sinapsis arvensis*. Above 25 lb. per acre the damage to the crop became excessive without a commensurate increase in weed control.

An application of 20 gallons per acre is attractive as it reduces the amount of water used to a minimum and this rate is relatively safe to the crop. Applications at 40 gallons gives insignificantly less damage to the crop and greater weed control than 20 or 100 gallons per acre. In the three trials harvested greater yield increases were recorded following spraying at 100 gallons, although there was slightly poorer and less consistent weed control.

From the limited amount of experimental evidence available there seems no reason why SMCA should not be developed for use on other brassica crops with the possible exception of cauliflowers. Turnips and swedes, however, were too severely checked in small trials to warrant field scale experimental work.

SMCA was compared with pentachlorphenol as a pre-emergence contact weedkiller and despite some evidence of persistence in the soil, was not as efficient. Some crops were damaged by pre-emergence application of SMCA.

Although sodium and potassium cyanates were less damaging to kale than SMCA under all conditions, satisfactory weed control with these chemicals was only obtained in warm humid weather. SMCA gave a more satisfactory control of weeds under a wider range of conditions than did the cyanates under ideal conditions.

SMCA was much less damaging to kale than was sulphuric acid. Despite this it was only slightly less efficient as a weedkiller. SMCA is not quickly absorbed by the plant, rain falling soon after application limits effectiveness, but rain falling twelve hours after made little difference to weed kill.

References

[1]Breese, T. C., Wheeler, A. F. J., Control of Hormone Resistant Weeds in Cereals. *British Weed Control Conference*, 1956. Vol. II, p. 759.

New Developments and New Products

The Wellcome Laboratories

In these laboratories where all benches are surfaced with Formica Decorative Laminates, Anti-tetanus is produced.

Formica Curved Surfaces

In this modern laboratory, the work-tops have been surfaced with Formica, specially curved at front and back edges by the post-forming technique, thus dispensing with unnecessary joints into which germs can lodge.

New Spray for prevention of Warble Fly Attack

H. E. Helman & Co. (Insecticides) Ltd., manufacturers of " Spray-Mite " announce the introduction of a new chemical, to be called "Warble-Mite" which it is claimed prevents Warble Fly attack. The repellant action of this spray eliminates irritation and panic during the season when Warble Fly is prevalent. This means that both the milk yield and the overall health of the stock are maintained.

3 Years' Trials

" Warble-Mite " has been subjected to exhaustive tests during the last three years; details of three typical experiments are given below:

In 1955, forty-five twelve months old Aberdeen Angus were sprayed with "Warble-Mite" and then allowed to range on Dartmoor for the whole of that year. Periodic checks were taken—no instances of Warble attack were experienced.

In another test, one hundred and twenty head of cattle in S. Ireland were treated in 1957. One animal only was attacked by Warble Fly and this notable invasion force consisted of—one single grub.

Again in 1957, one dairy cow was sprayed and ran the whole year with a herd of two hundred known to have been attacked with Warble. The sprayed animal remained completely free.

Method of Use

One spray per year ensures immunity from Warble Fly attack. It is recommended that treatment be carried out between January and March.

The method of application is simply to spray the back and flanks of each animal from an approximate distance of three feet. Only where cattle are exposed to severe frost within twelve hours of treatment is it necessary to re-spray.

A new cheaper Systemic Insecticide

A new British systemic insecticide has been developed which it is claimed will offer marked (6/- acre) economic advantages to the farmer whilst being extraordinarily effective against aphis of all kinds. It has no smell, is easy to handle, and it has been agreed by Government departments that its use on sugar beet, under the conditions stated on the label is unlikely to lead to a hazard to consumers of either the sugar, the molasses, the sugar beet tops or sugar beet pulp. Unlike most other systemics, it is not an anticholinesterase inhibitor. In the first instance it will be used on sugar beet and non-edibles but it is hoped later in the year to get clearance on field beans, cabbage, sprouts, and other vegetables. It will be appreciated that aphis, notably the peach potato aphis and the black bean aphis (blackfly) are the carriers of the very serious disease on sugar beet known as virus yellows. Official sources state that virus yellows in a normal year cost the industry £1 million, and in bad years considerably more.

This insecticide is claimed to be the most active aphicide yet discovered. It is normally used in a low dosage per acre, using 10-50 gallons of water and its aphicidal effect is very marked within 24 hours. Under normal conditions it will provide protection for up to 21/28 days after spraying. It does not deteriorate on standing.

It has, not only systemic properties, but also contact properties and fumigant properties.

The material is entirely British produced. In trials, it has been shown to kill the very difficult to kill woolly aphis, and there is reason to hope it might solve the serious problem of big bud in blackcurrants.

A cheaper, efficient and easier to handle insecticide will, it is hoped, lead to more spraying being done and more aphis destruction, particularly of host plants where these pests over winter-costs of spraying these, it is felt, have previously held this back to a considerable extent. The insecticide which is being marketed jointly by Leek Chemicals, Ltd., and Associated Fumigators, Ltd., is lethal to aphis at the concentration of 1 part in 20,000 parts of water.

NEWS

A system " unique in the western world "—that of the scheme for notification of hazardous pesticides—a scheme operated voluntarily by the manufacturers themselves, was referred to by Dr. E. E. Turtle, M.B.E., Chairman of the Pesticides Group of the Society of Chemical Industry, on the 16th February at a dinner of the Pesticides and the newly-formed Surface Activity Group of the Society.

This scheme, operated voluntarily, was in marked contrast with the rigid schemes enforced on the industries of certain other countries.

Despite all the difficulties, he said, there appeared to be no slackening in the production of new pesticides.

The Chairman of the newly-formed Surface Activity Group, Sir Eric Rideal, proposed the toast of the Pesticides Group and said that there was little doubt but that the livelihood of the ordinary man-in-the-street depended increasingly on the activities of the Pesticides Group.

The President of the Society, Sir Robert Robinson, O.M., F.R.S., the President of the Society, proposed the toast to the Surface Activity Group.

Marketing Executive appointed by Pyrethrum Board of Kenya

Sir Thomas Bowen, Bart., has been appointed to the newly created post of Marketing Executive of the Pyrethrum Board of Kenya, who are implementing plans for intensifying sales of the natural insecticide which has in the last few years regained favour in world markets.

This appointment has been made following upon the Board's decision to adopt in principle recommendations made by a United Kingdom firm of business consultants in respect of certain administrative arrangements and sales organisation.

It is the intention of the Board to expand its sales in existing markets and enter new ones. Sir Thomas who will have his office at the Board's headquarters in Nakuru, Kenya, will be travelling to many parts of the world on behalf of the Board.

Mr. E. W. M. Fawcett, Technical Director and Mr. H. P. P. Hodgkins, Commercial Director of Howards of Ilford Ltd., have been appointed to the Board of the parent company, Howards & Sons Ltd.

At the last meeting of the Committee of the Pesticides Group, Society of Chemical Industry, held on 16th February, the following officers were elected: Dr. E. E. Turtle (Chairman), Mr. G. L. Baldit (Vice-Chairman), Dr. J. Allan (Hon. Treasurer), Dr. B. J. Heywood (Hon. Recorder), Mr. K. Wilson-Jones (Hon. Secretary).

The members of the Committee during 1958-59 were: Mr. A. L. Abel, Mr. G. L. Baldit, Dr. J. K. Eaton (Co-opted), Dr. M. Elliott, Dr. R. A. E. Galley, Mr. H. K. Heseltine, and Mr. A. Taylor.

Under Rule 7, the following two members are due to retire in July, 1959: Mr. A. Taylor and Mr. A. L. Abel.

Mr. S. W. Cheveley, Chairman of the I.C.I. Central Agricultural Control since 1952, retired at the end of March. Mr. Cheveley, who has completed 35 years' service with the British Sulphate of Ammonia Federation, Nitram Ltd. and I.C.I., was the first secretary of Jealott's Hill Research Station. In 1941 he was appointed a director of Plant Protection Ltd. and became managing director of that company in 1944. Also in 1944 he joined the boards of I.C.I.'s Central Agricultural Control and Scottish Agricultural Industries Ltd. He is succeeded as chairman by Mr. R. A. Hamilton, who retains his appointment as development director of I.C.I. Billingham Division.

Big Bud Mite Control with " Endrex 20 "

The Ministry of Agriculture have now agreed to the extended use of endrin on Blackcurrants for Big Bud Mite control. This will enable many growers to combat successfully a pest which has been found most difficult to control by other chemicals.

Trials by the National Agricultural Advisory Service and by Shell Chemical Company Limited over the past three years have shown that post-blossom application gives an excellent control of the mite as well as capsid and blackcurrant leaf midge-whilst the pre-blossom application of " Endrex 20 " gives a very good control of aphids, and partial control of Big Bud Mite.

The application of endrin, post-blossom, to blackcurrants grown under contract for juice manufacture is approved. The spray concentration should not exceed 0.04% endrin, which is provided by 1½ pints of " Endrex 20 " per 100 gallons of water; this application to be made as soon after flowering as possible.

On blackcurrants, grown for consumption in any form, a late pre-blossom application of endrin is approved, whilst non-fruiting bushes and plantation stock may be sprayed at any time.

Experimental work by the Shell Company has shown that no residues were detectable by chemical analysis, either on the ripe fruit as a result of the pre-blossom application, or in the juice following the immediate post-blossom application. Therefore, there are no limitations on the uses of the whole fruit or juice following treatment at the late grape stage or on the extracted juice following the post-flowering treatment. Small residues of endrin were found on the skins of the berries at harvest following the post-flowering treatment. In view of this, the Ministry has recommended that pomace, or skins, from blackcurrant juice manufacture should not be used for human consumption. The Ministry of Agriculture will be reviewing these recommendations at the end of the year.

" Endrex 20 " has been used for a number of years for the control of aphids and caterpillars on apples and other top fruit. It also controls Tarsonemid mites on cyclamen and other ornamental plants. " Endrex 20 " can be obtained from Shell Chemical Company's Appointed Distributors in 1 gallon tins at 122/6d. per gallon or in 5 gallon drums at 120/-d. per gallon.

Dr. B. P. Uvarov, Director of the Anti-Locust Research Centre since it was established in 1945, retired on 31st March, 1959. He has been succeeded by the Deputy-Director, Dr. T. H. C. Taylor.

BOOK REVIEWS

The Insect Pests of Cotton in Tropical Africa

By E. O. Pearson, Director, Commonwealth Institute of Entomology, assisted by R. C. Maxwell Darling, O.B.E. and published by " The Empire Cotton Growing Corporation " and " The Commonwealth Institute of Entomology."

This book is well compiled and could probably become a " must " for specialists working on African cotton pest problems and also for non-entomologists who are concerned with the welfare of the cotton crops. It embodies the results of 30 years research in Africa and yet it is in the modern idiom with its emphasis on the ecological approach and on the importance of population studies particularly with regard to the relations between the insect and the host plant and between insect outbreaks and methods of growing cotton.

The author first gives an account of cotton growing in tropical Africa in which he deals with the botany and origin of the true cottons and the early introductions of cultivated cotton. He then deals with the insects and the cotton plant, including the systematic and geographical distribution and the origins of pests of cotton.

These two chapters are followed by a key to the principal disorders of cottons and to quote the author " The key is intended primarily for use in the field, and its object is to enable users who may not have technical knowledge of entomology or plant pathology to diagnose, with the unaided eye, any of the principal disorders from which cultivated cotton suffers in Africa."

The main part of the book is taken up by accounts of the principal pests and these accounts are arranged first systematically (i.e. by orders) then according to the part of the plant attacked and finally by families. This section includes a number of beautiful instructive coloured plates.

There is an appendix on " The use of insecticides on cotton in Africa " written by Mr. Maxwell Darling, but due no doubt to the large numbers of problems regarding the use of chemical control in Africa, he has refrained from advocating any definite policy.

On the whole this is a very worthwhile book for people concerned with cotton.

Publications Received

The Murphy Crop Protection Handbook.

Issued by the Export Department of The Murphy Chemical Company Ltd., Wheathampstead, St. Albans, Herts.

We cannot recommend this handbook too highly, for those in overseas' countries. It comprises 64 pages and our advice is " Write for it! " It is as simple as that: a letter to the Export Department of the Company will bring this invaluable publication by return. Contents include rodenticides, Malathion Bait Sprays, Spraying Do's and Dons't, Varietal Susceptibilities, Precautions for Phosphorous Insecticides, Precautions for BHC Products, Low Volume Spraying, Mill's Tables, Toxicological Data, Slug Killers are some of the sections.

One product of especial interest in the field of public health and sanitation is Hexagerm EC-10, which is a powerful insecticide containing BHC combined with strong disinfectants. The product is therefore particularly applicable in situations where insect pests and dirt occur together, e.g., cockroaches breeding in sewers, flies breeding in refuse tips and flies attracted to lorries used for carrying away night soil.

Another product which is also of interest is the So-Dead Fly Bait. This product, which is supplied in 3 lb. and 14 lb. tins, is used to destroy flies without the need to spray in any shape or form. All that is necessary is to sprinkle the product in areas where flies are seen to congregate. The bait is attractive to flies for feeding and when they feed on it they are rapidly killed. The bait is coloured so that it cannot be confused with food or animal feedstuffs and contains an insecticide of very low mammalian toxicity so that it is very safe to use. Furthermore the insecticidal ingredient is one against which flies have not developed resistance.

Manufacturers of these two products are The Standardised Disinfectants Co. Ltd., 23 Sloane Street, London, S.W.1.

The Dorman Osprey Ace Operated Knapsack Sprayer

Shown for the first time on 19th March at the Hoveton Fruit Farm, Wroxham, Norfolk, was the Dorman Osprey Ace Knapsack Mister/Duster, manufactured by The Dorman Sprayer Co. Ltd.

This sprayer powered by a 75 cc. petrol engine developing 3 B.H.P. at 4,000 r.p.m. is suitable for wet spraying, dusting and wet dusting. The sprayer is of light weight only 35 lbs. complete and is very well balanced so that operator fatigue is reduced to a minimum. The engine and fan unit are flexibly mounted, vibration and heat are not transmitted through to the operator's back. Due to the low speed of the engine the high pitch scream associated with high speed engines is absent and maintenance is reduced to a minimum. The liquid tank is mounted vertically for stability. The sprayer will also pass comfortably through an ordinary green-house door. Controls are conveniently mounted and are arranged to be in front of the operator so that he has perfect control, at all times.

For liquid spraying the Polythene tank holds 2¼ gallons of liquid which is pressurised to ensure uniform application at whatever height the nozzle is held. Rate of application can be varied from under ½ pint to 2¾ pints per minute. Atomization is ensured by the high speed air stream which reaches a velocity of 267 m.p.h. the speed being controllable to suit the application in hand. For dust spraying, the hopper holds 9 lbs. of dust and the dust is agitated by the air stream before entering the delivery tube. For wet dusting, a smaller tank is added and a very small quantity of liquid is atomized into the dust stream as it leaves the nozzle ensuring ideal conditions for adhesion of dust on the plant under treatment.

A flame gun can be supplied which is of particular value for pre-emergence flame weeding of slow germinating vegetable and fruit crops.

Forthcoming Events

International Agricultural Aviation Conference:

14th-19th September.

A residential Conference will be held at the College of Aeronautics, Cranfield, Bedfordshire, England. The Conference will assemble during the evening of Monday, 14th September and disperse after breakfast on Saturday, 19th September.

The programme is being organised jointly by: The Ministry of Agriculture, Fisheries and Food; The Ministry of Transport and Civil Aviation; The Colonial Office; The European Agricultural Aviation Centre, The Hague, Netherlands; The Royal Aeronautical Society; The Society of Chemical Industry; The National Farmers' Union; The Association of British Manufacturers of Agricultural Chemicals; The Fertiliser Manufacturers Association; The National Association of Agricultural Contractors.

Fees and Accommodation: The Conference Fee, inclusive of accommodation, meals, hospitality and gratuities, will be £14. There will be no extra charges. The fee will also entitle registered members to one copy of the Proceedings.

Registration: Registration forms may be obtained from the Ministry of Agriculture, Fisheries and Food, Room 218, Great Westminster House, Horseferry Road, London, S.W.1, or from Dr. W. J. Maan, Director of the European Agricultural Aviation Centre, le v.d. Boschstraat 4, The Hague, Netherlands.

Papers and Programme: Offers of Papers or Progress Reports for discussion are invited (not later than 1st June, 1959), from European scientific or technical workers and operators for submission to the Editorial Panel at either of the above addresses. Formal Papers will be by invitation. The Programme will cover the following aspects:

First Day: Introductory Paper: Review of Developments in Agricultural Aviation.

AGRICULTURAL CHEMICALS AND FERTILISERS INCLUDING BIOLOGICAL EFFICIENCY

1st Session: Physical Qualities of Dry Agricultural Chemicals intended for Aerial Application.
2nd Session: Liquid Carriers and Solvents used in Aerial Spraying Progress Report Session (including Biological Aspects).
3rd Session: The Drift Hazard. Physics of Falling Droplets and Particles Progress Report Session.
Second Day:

AIRCRAFT, EQUIPMENT AND CORROSION PROBLEMS

1st Session: Aircraft; The Operators' Requirements. Progress Report Session.
2nd Session: Distribution Equipment. Progress Report Session (Evaluation of Various Types of Equipment).
3rd Session: International Airworthiness Standards. Progress Report Session.
4th Session: Corrosion Problems. Progress Report Session.
Third Day: ECONOMICS AND FLYING
1st Session: Economic Factors Affecting Agricultural Aircraft Operations. Progress Report Session.
2nd Session: Safety Precautions. Progress Report Session.
3rd Session: Techniques of Low Flying. Progress Report Session.
4th Session: Ground Organisation and Equipment. Progress Report Session.
Fourth Day: DEMONSTRATION
Languages: The official languages for the Conference will be English and French.
Demonstration: A Demonstration is being arranged by the British National Association of Agricultural Contractors in conjunction with the Conference. This will include a flying display of agricultural aircraft and application equipment.

The rearranged meeting of the Pressure Packaging Discussion Group of the Institute of Packaging to discuss " Biological Assay of Aerosol Insecticides " will take place at the Packaging Centre, 50 Poland Street, London, W.1., at 7 p.m. on Wednesday 8th April.

The discussion is to be introduced by Mr. F. G. S. Whitfield of Avebury Research Laboratories and Mr. K. Goodwin-Bailey of Cooper, Mc. Dougall & Robertson Ltd.

Agricultural Work Study — Second Basic Training Course for Agricultural Work Study Specialists

A twelve-week Course of training for people who will become specialists in Agricultural Work Study has been organised by Imperial Chemical Industries Ltd.

The Course, which began on 23rd February, will continue until 15th May. It will consist of five weeks of theoretical training based on Imperial Chemical House, London, and seven weeks of practical work covering a wide variety of agricultural tasks on farms in the Midlands. The purpose is to provide a nucleus of very highly trained personnel capable of training others who, in their turn, will pass on knowledge of the most up-to-date and successful work study methods to those engaged in farming and farm management.

Because of the intensive nature of the training not more than sixteen people can be instructed conveniently at one time. Fourteen members of the Course have been nominated by the Ministry of Agriculture, Fisheries and Food in such a way as to cover a variety of interests. They represent the Ministry, the Northern Ireland Ministry of Agriculture, universities, an agricultural college, the National Farmers' Union, the National Union of Agricultural Workers, the Chartered Land Agents' Society, and the National Institute of Agricultural Engineering (the latter nominated in conjunction with the Agricultural Research Council). Two members have been nominated by I.C.I.

Instruction will be given by members of Imperial Chemical Industries Ltd. drawn from the staff of Central Work Study Department and the Agricultural Work Study Unit. It will follow the pattern of the first Course held in February/May 1958 by I.C.I. at the instigation of the Ministry of Agriculture and representative agricultural organisations. As a result of the success of this first Course, the Minister of Agriculture, Fisheries and Food requested I.C.I. to organise a second one in 1959.

Stronger advertising for I.C.I's Garden Products, made by Plant Protection Ltd., is reported in the third issue of " Garden News."